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WEAR ANALYSIS OF RICE HUSK SHELL POWDER REINFORCED EPOXY COMPOSITE

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ABSTRACT

Nowadays, with the awareness of the public along with strict legitimate forces over the use of polymers, the manufacturing and automotive industries started using the renewable materials. In this regard, rice husk powder reinforced composites play a vital role in developing lightweight structural materials. This study focuses on utilizing rice husk as reinforcement filler loading (10%, 20%, 30% treated and untreated) in epoxy resin. This composite was fabricated using hand lay-up process. The influence of filler volume fraction on the wear properties of rice husk filler was studied in this work. Test results revealed that the composite with 20% volume fraction treated rice husk reinforced epoxy composite has better wear properties.

KEYWORDS: Natural Composite, Rice Husk Shell Powder & Wear Analysis

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Original Article

1. INTRODUCTION

Composites are nowadays manufactured using various agricultural residues mainly rice husk, which are obtained from during processing of rice. Agri residues are biodegradable and abundantly available material in south India. Various researchers have investigated the influence of waste particulate inclusion in polymer materials. As a filling material in epoxy composite, Sarki et al (2011) used coconut shell powder. The addition of coconut shell powder increased tensile strength and modulus with a mild decrease in impact strength. A coir fiber polyester resin with cocoe shell particulate has been studied by Vignesh et al (2015), and it has been found that coir fiber length with cocoe shell powered content size effects the mechanical composite properties. As recycled polypropylene filler, Chun et al (2013) used coconut shell powder, andSodium DedecylSulfate (SDS) as the connection agent. It showed that filler addition resulted in increased intensity, thermal stability, crystallinity and reduced water absorption when compared to unmodified composites. Kuburi et al (2017) have investigated the powder-filled cocoon shell powder composite made from low-density recycled polyurethane polymer matrix containing up to 14 wt%. The assessment showed that tensile strength, impact strength and bending properties and hydrophilic behaviour have increased, according to Muthukumar et al (1997). The development of polymer matrix composite using cocoon shell powder and groundnut shell polishes in various volume splits. The properties of the material are influenced greatly by the powder coconut shell and the powder shell. The coco shell powder-reinforces polymer composite was investigated by UdhayaSankar et al. (2015). The results showed that the addition of filler enhances mechanical characteristics such as strength and resistance to impact. Chandramohan et al (2017) studied

the coconut-shell powder organic particle composite, wall nut shell, and epoxy husk. This showed that, because of uniform filler and matrix dispersions, 20 volume percent of the filler provides better mechanical features and the modulus.

Onuegbu et al (2011) investigated rice husk powder based polypropylene composites of varying particle size. In an extrusion molding machine, the polypropylene composites were produced and the resulting composites were extruded as plates. The presence of pulverized rice husk enhances the tensile strength, modulus, bending strength and strength of the composites, which increases fill contents and reduces fill particle size. Rajuet al (2012) studied the use of groundnut powder as bio-filler. Groundnut shell particles incorporated composites were fabricated with different grain size and volume fraction. The studies indicate a volume ratio of 60:40 and 0.5micron particle size has provided the better reinforcement effect of the composite. Shanthiet al (2015) studied the effect of coir fiber as the main strengthening element and rice husk as an additional filler to enhance the mechanical properties of the vinyl ester composite. The impact test showed increase in impact strength to 50 wt percent of filler added. At the optimization point of the tensile testing, a small percentage of rice husks were added and tests have been done. Improvement of mechanical properties of the hybrid composite material, such as tensile strength and flexural resistance was observed. In the following sections, the study on utilizing rice husk as reinforcement filler loading (10%, 20%, 30% treated and untreated) in epoxy resin, and the wear analysis of all these six fabricated composites are presented.

2. WEAR TEST SPECIMENS

In this work, there are six composite specimens, fabricated using hand layup process (Figure 1), in which, treated and untreated rice husk was used as reinforcement filler loading with 10%, 20%, 30% volume in epoxy resin for fabrication. The wear test is carried out on an ASTM D3702 pin-on-disk (P-o-D) device (Figures 2 and 3). As shown, a flat steel disk with radius 16.5 mm was rotated in the specimen pin. The counterpart's initial surface ruggedness was 0.23 µm. All tests were conducted at room temperature for 5 hours in dry conditions. A displacement sensor observed the reduction of the height of the specimen. An iron-constant thermocouple was placed on the edge of the disk, recorded as the contact temperature, to monitor the temperature of the disks. A proportion between the tangential power and the normal load was recorded and calculated for the friction coefficient. Following the wearing test, the mass loss was measured to calculate the specific wear rate by using the equation $Ws = \Delta m/\rho.t.V_S.F_N$ (mm^3/Nm).

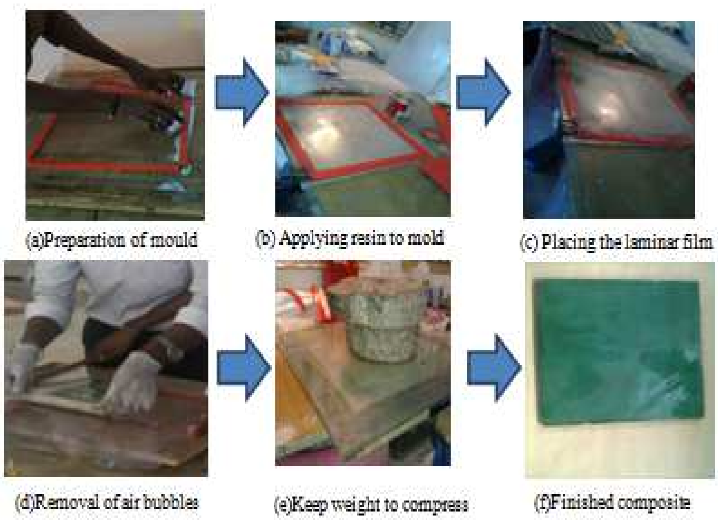

Figure 1: Composite Fabrication.

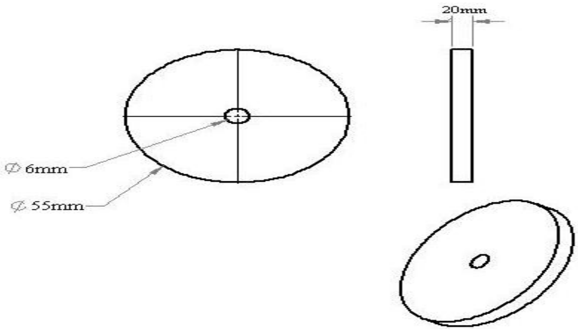

Figure 2: Dimensions of Wear Testing Specimen.

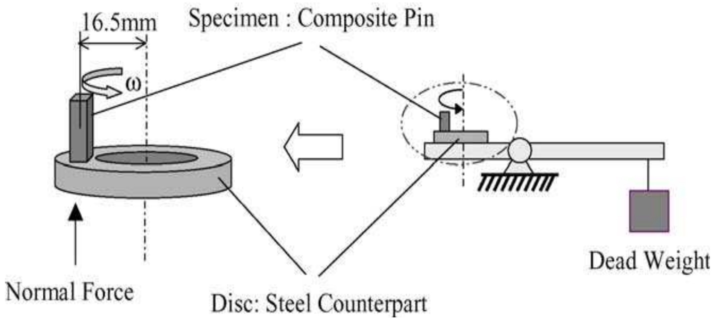

Figure 3: Schematic Diagram of Pin-on-Disc Apparatus.

3. RESULTS AND DISCUSSIONS

At a time of 60 seconds, upon varying the load and speed, the corresponding graphs were drawn below. From the graph, co-efficient of friction and frictional force values are tabulated. The wear properties with different TEST parameters of load (N), speed (rpm) and time (min), as listed in the table 1 were processed and planned to study three different types of composites. The samples are tested according to three different parameters. Three different loads, for which testing are used, and the sliding velocity and the sliding distance are maintained constant. Samples used for testing purposes are of three different compositions with 10, 20 and 30 percentage of treated and untreated rice husk mixed powder with the epoxy mixture.

Table 1: Test Parameters

Sl. No.	Applied Load(N)	Sliding Velocity(m/s)	Sliding Distance(m)
1	5	1	500
2	10	1	500
3	15	1	500

Table 2 presents the machine settings used for testing purposes. The sliding diameter of the machine is changed for every sample, and it is maintained as 26, 38 and 46 mm. Rpm is maintained as 735, 503 and 415 for each load in all the three compositions. The running time is maintained to be 500 seconds (8.332 minutes).

Table 2: Machine Setting

Sl. No.	Sliding Diameter (mm)	RPM	Time (Seconds)
1	26	735	500
2	38	503	500
3	46	415	500

3.1 Wear Loss of Untreated Rice Husk Composite for Different Loading

The wear loss is calculated from the initial and final weight values of the specimen, after the test has been conducted. The wear loss is calculated by using the formula.

Wear loss = (initial weight – final weight) / initial weight *100

Untreated rice husk shell powder reinforced epoxy composite wear loss are determined for 3 different loadind conditions viz. 5 N, 10 N, 15 N and the corresponding weight loss % are presented in tables 3–5. All the three different loadings show significant wear loss and these were plotted in figure 4–6.

Table 3: Weight loss % under 5N Loading

% of RH	Initial Weight (g)	Final Weight (g)	Weight Loss in %
10%	89.347	87.213	97.61%
20%	79.992	78.989	98.75%
30%	79.481	77.478	97.48%

Table 4: Weight loss %10N Loading

% of RH	Initial Weight (g)	Final Weight(g)	Weight Loss in %
10%	99.213	76.207	76.81%
20%	89.989	87.69	97.45%
30%	89.478	77.259	86.34%

Table 5: Weight loss % 15N Loading

% of RH	Initial Weight(g)	Final Weight (g)	Weight Loss in %
10%	99.207	94.945	95.70%
20%	79.69	76.671	96.21%
30%	79.259	74.808	94.38%

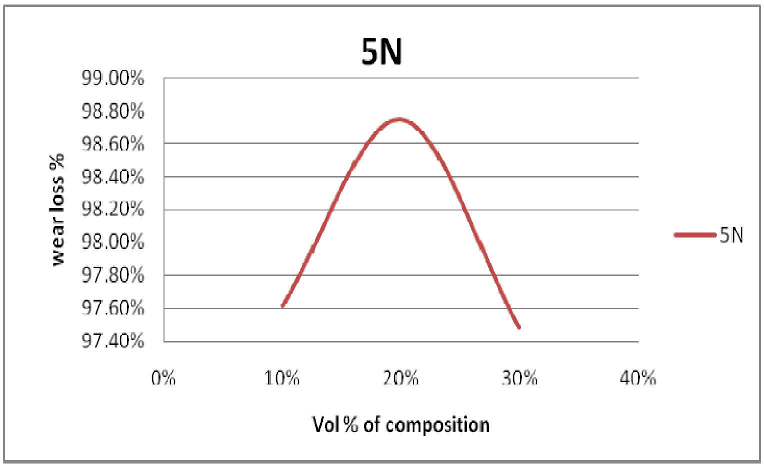

Figure 4: Untreated Rice Husk Epoxy Composite under 5N Loading.

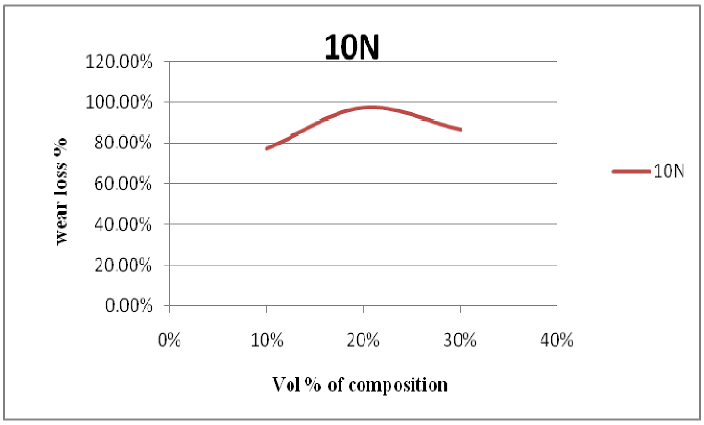

Figure 5: Untreated Rice Husk Epoxy Composite under 10N Loading.

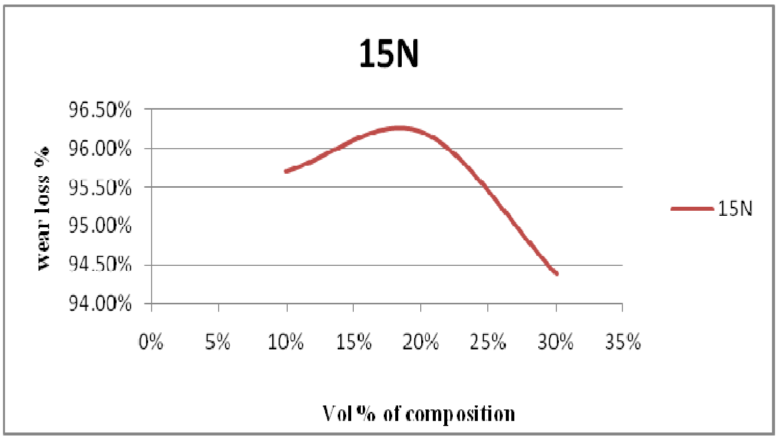

Figure 6: Untreated Rice Husk Epoxy Composite under 15N Loading.

3.2 Wear Loss of Treated Rice Husk Composite for Different Loading

The wear loss for malic acid treated rice husk shell powder reinforced epoxy compositeswere determined for 3 different loading conditions5 N, 10 N, 15 Nand the corresponding weight loss % are presented in tables 6–8. All the three different loadings show significant wear loss and these were plotted in figure 7–9.

Table 6: Weight Loss % under 5N Loading

% of RH	Initial Weight (g)	Final Weight (g)	Weight Loss in %
10%	89.347	89.213	99.85%
20%	79.992	79.989	100.00%
30%	79.481	79.478	100.00%

Table 7: Weight loss % under 10N loading

% of RH	Initial Weight (g)	Final Weight(g)	Weight Loss in %
10%	99.213	79.207	79.84%
20%	89.989	89.69	99.67%
30%	89.478	79.259	88.58%

Table 8: Weight Loss % under 15N Loading

% of RH	Initial Weight (g)	Final Weight(g)	Weight Loss in %
10%	99.207	98.945	99.74%
20%	79.69	79.671	99.98%
30%	79.259	78.808	99.43%

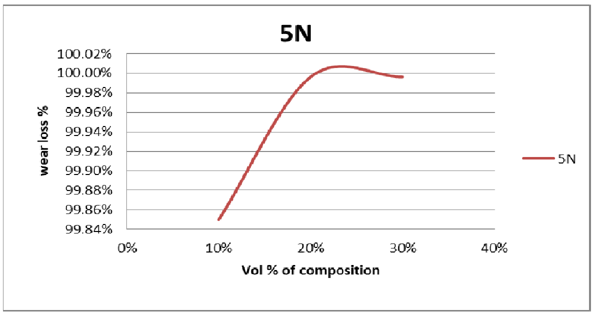

Figure 7: Treated Rice Husk Epoxy Composite under 5N Loading.

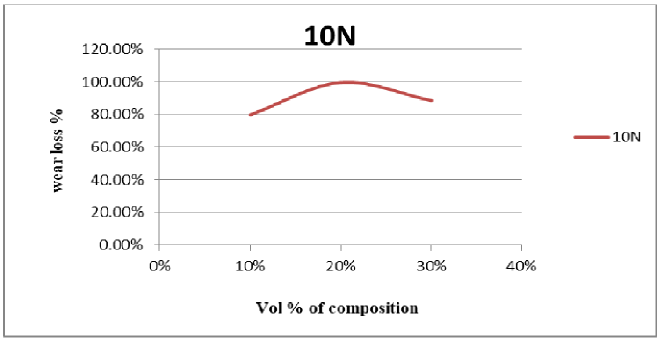

Figure 8: Treated Rice Husk Epoxy Composite under 10N Loading.

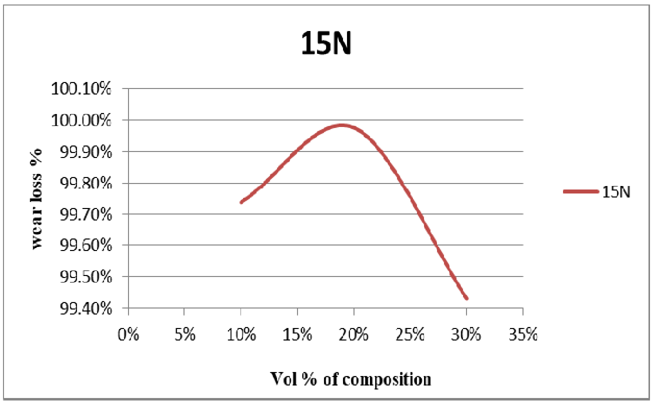

Figure 9: Treated Rice Husk Epoxy Composite under 15N Loading.

All the three different loadings show minimal wear loss compared to untreated rice husk epoxy composite. At 20 % volume fraction, rice husk shows less wear loss than other volume fraction. This is due to strong adhesion between rice husk particulates and epoxy in composite.

4. CONCLUSIONS

A new class of rice husk reinforced epoxy composite was prepared using hand layup technique. Wear analysis was carried out for untreated and treated rice husk composite with 10%, 20%,30% volume fraction of rice husk. Three different loads are used for testing and the sliding velocity, and the sliding distance are maintained constant. The specimens are tested in pin on disc apparatus by varying load and speed parameters to find out the wear loss. At 20% volume fraction of rice husk, the wear loss is less compared to others. Better filler and matrix interaction results in good interfacial adhesion between filler/matrix and fewer voids in the composite. Generally, high filler content results in good composite performance, but at a certain limit, the matrix does not adhere well with a saturated amount of filler, and the composite wear strength decreases.

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